BABA, NATSUKO. M.A. Air Passenger Demand and Metropolitan Economies: Key Predictors in the Pandemic Era. (2024)
Directed by Dr. Keith Debbage. 27 pp.

Given the disruptive impact of the COVID-19 pandemic on air passenger demand in the early 2020s, this paper attempts to establish if the traditional link between metropolitan economies and air passenger demand has been fundamentally altered during the pandemic era. It is hypothesized that as the employment share in tradable service sectors increases, air passenger demand will accordingly increase. Only those metropolitan areas that included airports that the Federal Aviation Administration (FAA) defined as air traffic hubs in 2021 were included in this analysis. Data were collected from the FAA and Census Bureau's American Community Survey. The top ten metropolitan areas that generated the largest air passenger demand in 2021 collectively accounted for nearly half of all passenger enplanements. A stepwise analysis was performed to examine the relationship between air passenger demand and a group of predictor variables using SPSS. In the final regression model, 41.2% of the variation in air passenger demand by metropolitan area was accounted for by four predictor variables: the percent of the workforce in Information, Transportation and Warehousing, Professional, Scientific, and Technical Services or PST, and Finance, Insurance, and Real Estate or FIRE. These results appear to confirm some of the earlier research which articulated that a regional workforce with a strong tradable services sector can substantially impact air transport provision. Even during the peak of the COVID-19 pandemic, certain business activities on the ground, particularly tradable services, can still help to generate additional air passenger demand and enhance competitive advantage.

AIR PASSENGER DEMAND AND METROPOLITAN ECONOMIES:

KEY PREDICTORS IN THE PANDEMIC ERA

by

Natsuko Baba

A Thesis
Submitted to
the Faculty of The Graduate School at
The University of North Carolina at Greensboro
in Partial Fulfillment
of the Requirements for the Degree
Master of Arts

Greensboro

2024

Approved by

_____

Dr. Keith Debbage
Committee Chair

APPROVAL PAGE

This thesis written by Natsuko Baba has been approved by the following committee of the Faculty of The Graduate School at The University of North Carolina at Greensboro.

Committee Chair

Dr. Keith Debbage

Committee Members

Dr. Rick Bunch

Dr. Zhi-Jun Liu

March 19, 2024

Date of Acceptance by Committee

March 19, 2024

Date of Final Oral Examination

ACKNOWLEDGEMENTS

Foremost, I would like to express my sincere gratitude to my advisor and chair, Dr. Keith Debbage, who made this work possible. His continuous support, thoughtful advice, and constant encouragement carried me through all the stages of researching and writing this thesis. I could not have imagined having a better advisor for my M.A. study and my entire life.

I would also like to thank my committee members, Dr. Rick Bunch and Dr. Zhi-Jun Liu, for all their invaluable teaching and insightful suggestions.

Last but not least, I would like to thank my family and friends for always believing, motivating, and supporting me from the opposite side of the world.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I: INTRODUCTION

Since the Airline Deregulation Act of 1978, the air transport market has seen significant growth in the United States. However, in recent years, the COVID-19 pandemic has negatively impacted air travel. While several crises, including 9/11, the MERS and SARS pandemic, and the global financial crisis of 2007/8, have historically destabilized air transport, the impact of the COVID-19 pandemic has been unprecedented (Hanson et al., 2022; Kim and Sohn, 2022). Air passenger demand in the US declined from 916 million passengers in 2019 to 367 million in 2020 – a precipitous 60% decline (United States Department of Transportation, 2022). The rapid decline in air passengers was, in large part, caused by travel restrictions linked to pandemic-related lockdowns and vaccine requirements. The impact of the COVID-19 pandemic along with the prevalence of online communications, the shift to teleworking, and changes in people's perceptions toward air travel and sanitation levels in the early 2020s may all have fundamentally altered the traditional connections between air passenger demand and metropolitan economies.

Previous research has suggested that a strong link exists between metropolitan economies on the ground and airline networks in the air. Much of that research has suggested that certain sectors of a metropolitan economy can generate elevated propensities to fly (e.g., a disproportionate share of white-collar knowledge economy workers) because of the need for face-to-face contact in making complex, creative, and substantive business decisions (Brueckner, 2003; Debbage and Delk, 2001; Florida et al., 2015; Mosbah and Ryerson, 2016). Given the disruptive impact of the COVID-19 pandemic on air passenger demand in the early 2020s, this paper attempts to establish if this traditional link between metropolitan economies and air passenger demand has been fundamentally altered in the pandemic era. The purpose of this paper is to investigate if a statistically significant relationship continues to exist between certain

business activities on the ground (especially the information technology sector, the finance, insurance, and real estate or FIRE sector, and the professional, scientific, and technical activities or PST sector) and air passenger demand by airport in 2021, for the peak year for the COVID-19 pandemic in terms of number of deaths (Center for Disease Control (CDC), 2022, 2023). The goal of this paper is to expand the existing literature's focus and provide new insights that have been informed by the turbulence generated by the COVID-19 pandemic.

CHAPTER II: LITERATURE REVIEW

There is considerable literature on the links that exist between airports, air traffic demand by airport, and regional economic growth. Cities and related government entities tend to describe air transport as a key booster of regional economic development regardless of its size and degree of economic impact (Green, 2007; Mosbah and Ryerson, 2016). Meanwhile, several other studies have attempted to more rigorously quantify the connections by investigating which sectors of the economy tend to generate disproportionately elevated levels of air transport demand by airport.

Brueckner (2003) has confirmed that a 10% increase in air passengers in a metropolitan area can generate a 1% increase in regional employment. He also argued that airports and airline traffic contribute more to knowledge and service-based businesses than manufacturing and other goods-related industries. As a result, he indicated that frequent airline service to a variety of destinations reflected in a high level of passenger enplanements can facilitate easy face-to-face contact, serve information-intensive businesses, attract new additional firms to the metropolitan area, and increase employment opportunities. Importantly, connectivity (a measure of the number of destinations served directly by airlines at the airport and of the frequency of those services) is especially high at airline hub airports (Mosbah and Ryerson, 2016), and metropolitan areas that contain hub airports have higher air traffic levels (Brueckner, 2003).

Additionally, an efficient air transportation network allows the movement of goods, services, and passengers in a more timely and reliable manner (Debbage and Delk, 2001). Florida et al. (2015) indicated that face-to-face interaction through the movement of people is also crucial in spurring new ideas and innovations even in the light of information technology services and electronic communication mediums that may mitigate the need for face-to-face contact. Green (2007) also argued that the Internet could be a complement, as well as a substitute

for face-to-face interactions. The Internet can replace some meetings by enabling people to communicate online, while it can generate additional demands that people wish to meet either for business or social purposes promoted through easy online first-touch communication. Therefore, it is certainly true that the Internet may contribute to generating additional air traffic demands than would exist in its absence.

The thorniest issue facing any investigation of the connections that exist between air service and regional economic development is the issue of causality. Can airports attract additional economic activity to a local area or do fast-growing, large metropolitan areas with substantive service sectors simply have larger airports in response to the elevated demand for air travel? Unraveling this "chicken or the egg" conundrum has been a central theme of the academic literature in recent years (Blonigen and Cristea, 2012; Button and Yuan, 2013; Neal, 2011, 2012; Sheard, 2014; and Van De Vijver et al., 2016). Based on more innovative methodologies linked to improved panel data, lagged regression analysis, and Granger causality testing, a consensus opinion has slowly emerged that the composition of the metropolitan economy – and particularly the proportion of the labor pool in tradable services – can be a positive and causal trigger in the production of additional air transport demand.

A service industry is "tradable" if a substantial proportion of its output can be feasibly produced in one location and consumed in another. According to Sheard (2014, p.147), "tradable services, which can be delivered to other locations partly by use of air travel, are therefore produced disproportionately in metropolitan areas that are more accessible by air…" Both Sheard (2014) and Grubesic (2010) have argued that the estimated effect of tradable services on airport demand appears to be driven largely by FIRE, PST, and information technology industries. Liu et al. (2006) partly confirmed some of this logic when determining that the log

odds likelihood of being a major air passenger market is primarily determined by a disproportionate share of the metropolitan labor pool in PST.

What is less clear is whether or not these well-established causal links between tradable services employment and air passenger demand have endured during the recent COVID-19 pandemic. Recent research has shown that tradable services workers – particularly the more creative, higher-income, and well-educated workers – tended to be the most likely to work at home or in more remote locations during the pandemic (*New York Times*, 2023). Consequently, it is possible that the recent reshuffling of the traditional work-home relationships, during the pandemic era, may have corroded the explanatory power of tradable services with respect to the geography of air transport demand.

CHAPTER III: DATA AND METHODS

The central focus of this paper is trying to better explain the geography of passenger enplanements in the COVID-19 pandemic era. According to the Federal Aviation Administration (FAA) (2022), enplanements refer to the boarding of an aircraft by a revenue passenger, including an original, stopover, or transfer boarding of the aircraft. Air passengers who change flights at transit airports can then be counted multiple times. Consequently, enplanement data captures not only the significance of originating markets but also the significance of air passenger hub markets. The main purpose of this paper is to determine whether the geography of air passenger demand (as measured by US air passenger enplanements by metropolitan area) is systematically related to employment share in certain key industry sectors, particularly in tradable services. It is hypothesized that as the employment share in tradable service sectors increases, air passenger demand will accordingly increase, even during the pandemic era.

Only those metropolitan areas that included airports that the FAA (2022) defined as air traffic hubs in 2021 were included in this analysis. The FAA classifies these hubs based on the percentage of total passengers enplaned at a given airport. The data set in this paper includes most of the FAA-defined large, medium, and small air traffic hubs. These airports are defined as follows:

- Large air traffic hubs: > 1% of annual US commercial enplanements.
- Medium air traffic hubs: 0.25 – 0.99% of annual US commercial enplanements.
- Small air traffic hubs: 0.05 – 0.24% of annual US commercial enplanements.

These FAA-derived hubs should not be confused with how airlines define a hub when describing their own hub-and-spoke route structures, which usually refer to a single airline operation.

In 2021, there were 145 FAA-defined air traffic hubs in the US although airports located outside of either the continental US or a metropolitan area were not included in this paper. This paper includes passenger data for the entire metropolitan area so in some instances, metropolitan areas may include data for more than one airport. Table 1 lists those metropolitan areas with more than one FAA-defined hub airport. Metropolitan areas were employed as the unit of analysis because labor markets tend to be metropolitan-wide, not exclusively city-based, in terms of the work trip commuting behavior. This paper analyzed airport demand generated by 111 metropolitan areas, which accounted for 96.5% of all enplaned passengers at FAA-defined hubs in 2021.

Table 2 lists the ten potential predictor variables from the literature linked to elevated air passenger demand. The employment data is derived from the North American Industry Classification System (NAICS) which is used by the US Federal Government to define industries. The industry sectors analyzed in this paper included NAICS 31-33 (Manufacturing), NAICS 48-49 (Transportation and Warehousing), NAICS 51 (Information), NAICS 52-53 (FIRE), NAICS 54 (PST), and NAICS 71-72 (Arts, Entertainment, and Recreation, and Accommodation and Food Services). In the literature, all these industries have been shown to enhance the geography of air transport demand, although a disproportionate share of manufacturing jobs is more likely to trigger additional air cargo demand, and NAICS 71-72 tends to be more connected to leisure travel since it is largely a surrogate measure of the tourist industry. Other variables included in the analysis were median household income ($), per capita income ($), and total population with a bachelor's degree or higher (25 years old or older) (%) to help capture more broadly affluent, well-educated metropolitan areas.

Table 1. Metropolitan Areas with Multiple Airports Ranked by Total Enplanements, 2021

	Metropolitan Areas and Total Enplanements (millions)	List of Airports
1	New York – 38.7	John F. Kennedy International Newark Liberty International LaGuardia Long Island MacArthur Westchester County
2	Dallas-Fort Worth – 36.5	Dallas-Fort Worth International Dallas Love Field
3	Chicago – 34.0	Chicago O'Hare International Chicago Midway International
4	Los Angeles – 33.69	Los Angeles International John Wayne/Orange County Ontario International Hollywood Burbank Palm Springs International Long Beach
5	Miami – 33.67	Miami International Fort Lauderdale/Hollywood International Palm Beach International
6	Houston – 21.8	George Bush Intercontinental William P. Hobby
7	Orlando – 20.8	Orlando International Orlando Sanford International
8	Phoenix – 19.7	Phoenix Sky Harbor International Phoenix-Mesa Gateway
9	San Francisco – 19.4	San Francisco International Oakland International San José Mineta International
10	Washington – 14.0	Ronald Reagan Washington National Washington Dulles International
11	Tampa – 9.9	Tampa International St. Petersburg-Clearwater International
12	Norfolk – 3.3	Norfolk International Richmond International

Source: Author's calculations based on data from FAA (2022).

Table 2. Summary Statistics for Dependent and Predictor Variables and the Correlation Coefficient between Passenger Demand and Each Predictor Variable by Metropolitan Area, 2021

Indicator	Variable	Mean	SD	Correlation Coefficient with Passenger Demand
Dependent Variable	Air Passenger Enplanement (#)	5.5m	9.1m	–
Employment by industry	% Manufacturing (NAICS 31-33)	9.4	3.8	−0.15
	% Transportation and Warehousing (NAICS 48-49)	5.8	1.5	0.16
	% Information (NAICS 51)	1.7	0.6	0.50**
	% FIRE (NAICS 52-53)	7.1	1.9	0.26**
	% PST (NAICS 54)	12.3	3.0	0.46**
	% Arts, Entertainment, and Recreation, and Accommodation and Food Services (NAICS 71-72)	8.6	2.1	0.003
Economic	Median household income ($)	70.9k	11.8k	0.38**
	Per capita income ($)	38.3k	6.2k	0.34**
Education	% Bachelor's degree or higher attainment (age ≥ 25)	36.5	6.3	0.30**
Health	COVID-19 mortality rate (per 100,000)	109.3	40.5	-0.14

n = 111 metropolitan areas

The COVID-19 mortality rate (per 100,000) derived from CDC (2022) is county-based.

Also, the COVID-19 mortality rate data for the Virginia Beach-Norfolk-Newport News metropolitan area is derived from Norfolk city data since cities and counties are independent of each other in Virginia.

**. Correlation is significant at the 0.01 level (2-tailed).

It also should be noted that the NAICS data was collected from the American Community Survey (ACS) 1-year estimates published by the U.S. Census Bureau. Although the ACS multiple-year average estimates are superior to the single-year estimates in terms of statistical data reliability, the single-year estimates were chosen because they provide the latest information (U.S. Census Bureau, 2020). Additionally, the COVID-19 mortality rate (per 100,000) data set was obtained from the CDC (2023) for the largest central, urban county in each metropolitan area to see how the COVID-19 pandemic might have altered the geography of air passenger demand.

A two-tailed Pearson correlation coefficient analysis was completed using all the variables prior to performing linear regression to 1) assess whether statistically significant relationships exist between passenger enplanements and each independent variable separately and 2) reduce the potential for collinearity in the regression analysis by identifying statistically significant correlations between independent variables. Linear regression was then performed using the stepwise procedure to identify the most powerful predictors of passenger enplanements by metropolitan area.

CHAPTER IV: FINDINGS

4.1 Spatial Distribution of Air Passengers by Metropolitan Area

Table 3 lists the top ten metropolitan areas that generated the largest air passenger demand in 2021, and these ten markets collectively accounted for nearly half of all passenger enplanements (i.e., 49.8%). The six largest passenger markets highlighted in Figure 1 included New York, Atlanta, Dallas-Fort Worth, Chicago, Los Angeles, and Miami. Two major factors may have triggered the intense geographic concentration of air passenger demand in these select metropolitan areas. In the case of New York, Los Angeles, and Miami, these metropolitan areas largely operate as international gateways to Europe, Asia, and/or Latin America – although each metropolitan area contains several airports with their own unique market niches. With regard to Atlanta, Dallas-Fort Worth, and Chicago, the major airport in each of these respective metropolitan areas acts as the base for large airline-based hub and spoke network operations including Delta Airlines (Atlanta), American Airlines (Dallas-Fort Worth), and United Airlines (Chicago). Atlanta stands out because it is the only metropolitan area of the top six that features just one airport – Hartsfield Jackson Atlanta International Airport, while all the other metropolitan areas are more geographically sophisticated multi-airport markets with up to six airports in the case of the Los Angeles metropolitan area – a reflection of its complex polycentric urban structure.

4.2 The Regression Analysis

A stepwise analysis was performed to examine the relationship between air passenger demand and a group of predictor variables using SPSS (Table 4). Diagnostic tests indicated that the final regression model exhibited low multicollinearity among independent variables and met assumptions of linearity and normality. All the independent variables were significant at the

P<0.05 level. In the final regression model, 41.2% of the variation in air passenger demand by metropolitan area was accounted for by four predictor variables: the percent of the workforce in Information, Transportation and Warehousing, PST, and FIRE.

The first variable to enter the regression model was the percent employed in Information (NAICS 51). The metropolitan labor markets with the most disproportionate shares of Information workers included San Francisco (4.2%), Los Angeles (3.7%), Seattle (3.4%), and New York (3.2%) (Table 5 and Figure 2). Furthermore, the average number of Information workers for the top ten metropolitan areas (i.e., 3.14%) was nearly double that for all 111 metropolitan areas (i.e., 1.69%), and most of the metropolitan areas listed in Table 5 are instantly recognizable as major air passenger markets.

Table 3. Metropolitan Areas Ranked by Total Enplanement, 2021

Rank	Metropolitan Area	Total Number of Enplanements (#)	Enplanements (%) (n=111)
1	New York	38,715,139	6.32
2	Atlanta	36,676,010	5.98
3	Dallas-Fort Worth	36,492,829	5.95
4	Chicago	34,031,593	5.55
5	Los Angeles	33,698,037	5.50
6	Miami	33,666,987	5.49
7	Denver	28,645,527	4.67
8	Houston	21,803,601	3.56
9	Charlotte	20,900,875	3.41
10	Orlando	20,793,309	3.39
	Top Ten Average	30,542,391	4.98
	Top Ten Total	305,423,907	49.8

Source: Author's calculations based on data from FAA (2022).

Figure 1. Spatial Distribution of Air Passengers by Metropolitan Area, 2021

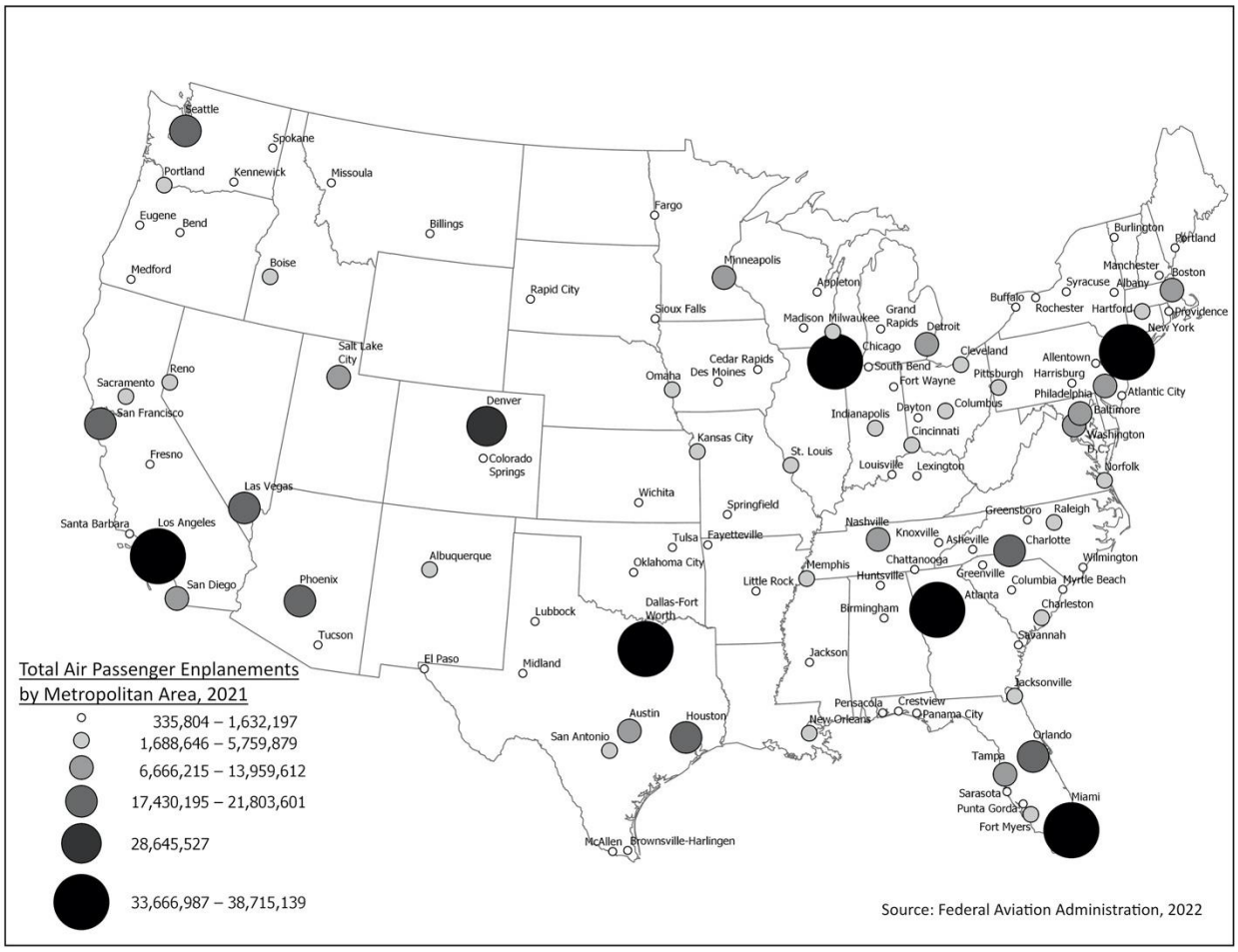


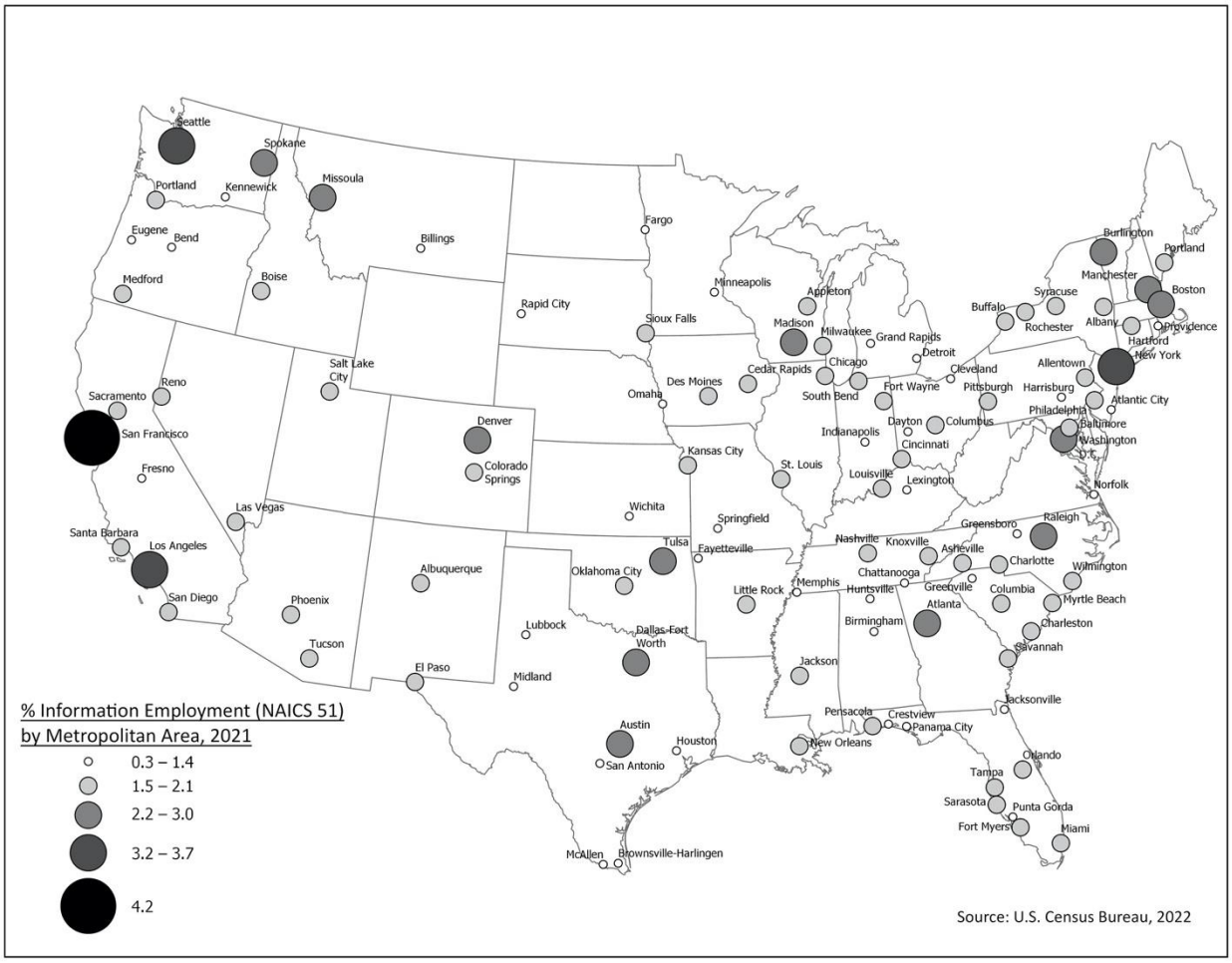
Table 4. The Final Regression Model for Passenger Enplanements by Metropolitan Area, 2021

Model ($R^2 = 0.41$)	Unstandardized β	Coefficients Std. Error	Standardized Coefficients data	t	Sig.
Constant	-32,621,338	5,160,351		-6.322	<.001
% Information (NAICS 51)	4,958,876	1,352,140	.338	3.667	<.001
% Transportation and Warehousing (NAICS 48-49)	1,884,966	480,633	.301	3.922	<.001
% PST (NAICS 54)	981,331	286,075	.317	3.430	<.001
% FIRE (NAICS 52-53)	954,463	373,025	.193	2.559	.012

Table 5. Metropolitan Areas Ranked by Information (NAICS 51) Employment (%), 2021

Rank	Metropolitan Area	% Information
1	San Francisco	4.2
2	Los Angeles	3.7
3	Seattle	3.4
4	New York	3.2
5	Denver	3.0
5	Missoula	3.0
7	Burlington	2.9
8	Atlanta	2.7
9	Manchester	2.7
10	Austin	2.6
	Top Ten Average	3.14
	n =111 Metropolitan Areas Average	1.69

Figure 2. Spatial Distribution of Information Employment (%) (NAICS 51) by Metropolitan Area, 2021



Much of this sector of the economy is engaged with producing and distributing information and cultural products as well as processing data. Some of the key sub-sectors include software publishing, motion picture and sound recording studios, broadcasting, telecommunications as well as data processing, hosting, and related services. Previous research has suggested that these sorts of firms along with the FIRE and PST sectors are capable of generating various services that can be "consumed" in other locations (Grubesic, 2010; Lakew, 2015; Sheard, 2014). Lakew (2015, p.60) has recently argued that "employees in the tradable service industries may benefit from the networking and face-to-face contact advantages afforded by air travel."

The Brookings Institution (2022) also recently indicated that information technology industries have long been highly concentrated in a short list of coastal "superstar" cities such as San Francisco, Seattle, and New York. In the San Francisco metropolitan area, some of the key firms include the corporate headquarters of Dropbox, Facebook, and Salesforce which all provide pivotal data processing, hosting, and related services. By contrast, second-ranked Los Angeles has long been the home to a wide range of motion picture and sound recording studios including Columbia Pictures, Paramount, and Warner Brothers while Seattle hosts the corporate headquarters of both Microsoft and Amazon. Although the New York metropolitan area ranked fourth in relative terms (%), it was the largest labor market in the country in an absolute sense (#) with just over 301,419 Information workers reflecting the broad, highly diversified nature of the labor pool.

Additionally, the Information sector has historically generated one of the largest employment multipliers of any tradable service with the Economic Policy Institute (2019) recently suggesting that for every 100 direct jobs generated in Information industries, an

additional 573 indirect and induced jobs are generated in terms of backward (i.e., suppliers) and forward (i.e., wages spent in other economic sectors) linkages. It is this sort of logic that may explain why Information was the first tradable service to enter the regression model. The other tradable services in the final regression model included PST and FIRE (Figure 3 and Figure 4). According to Grubesic (2010) and others, regional workforces with strong Information, PST, and FIRE sectors can all have a substantive and positive impact on air transport provision. The findings of this paper seem to confirm this prior research although Grubesic (2010) reported a higher R-squared value of 0.52. However, Grubesic (2010) focused on route capacity rather than enplanements, and the analysis was conducted well before the COVID-19 pandemic.

Figure 3. Spatial Distribution of FIRE Employment (%) (NAICS 52-53) by Metropolitan Area, 2021

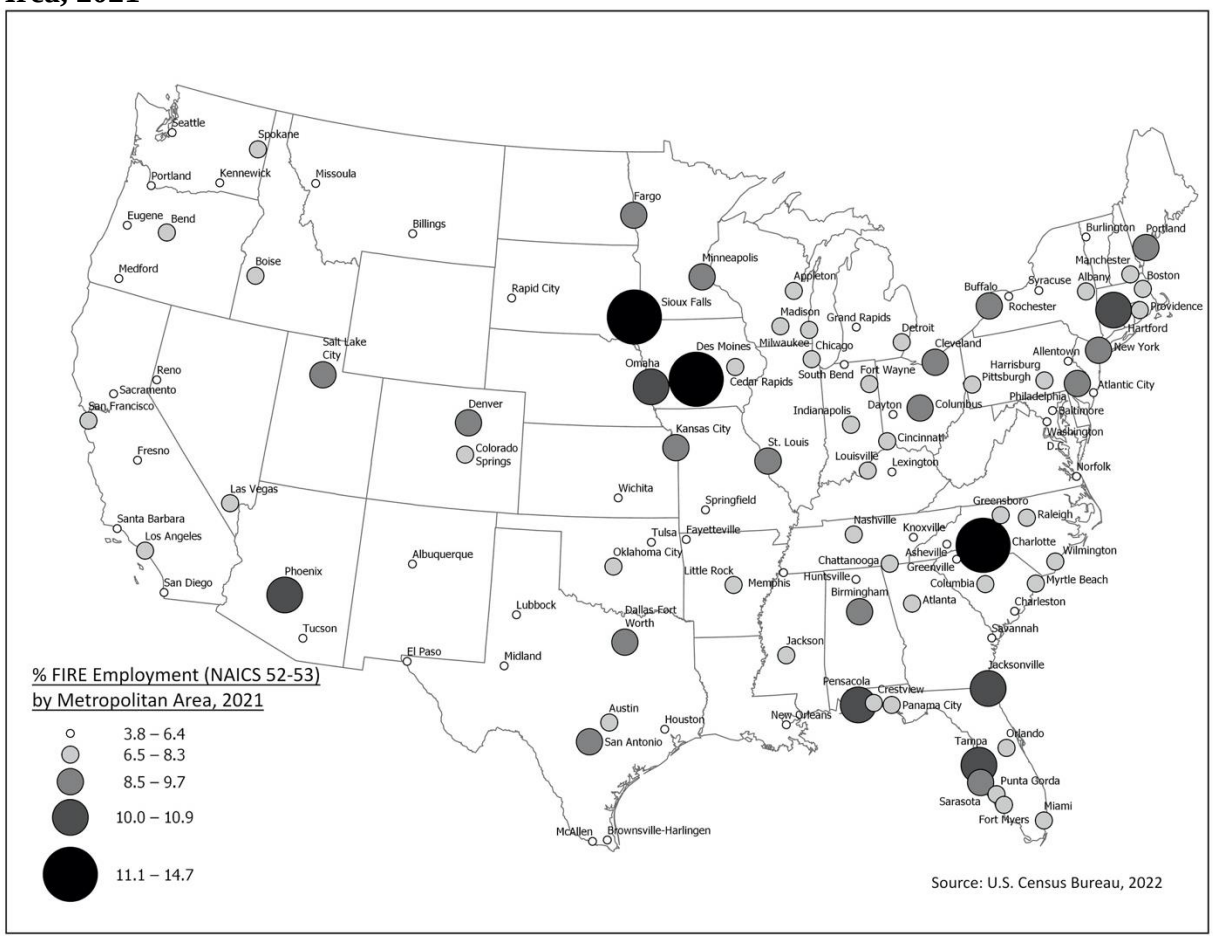
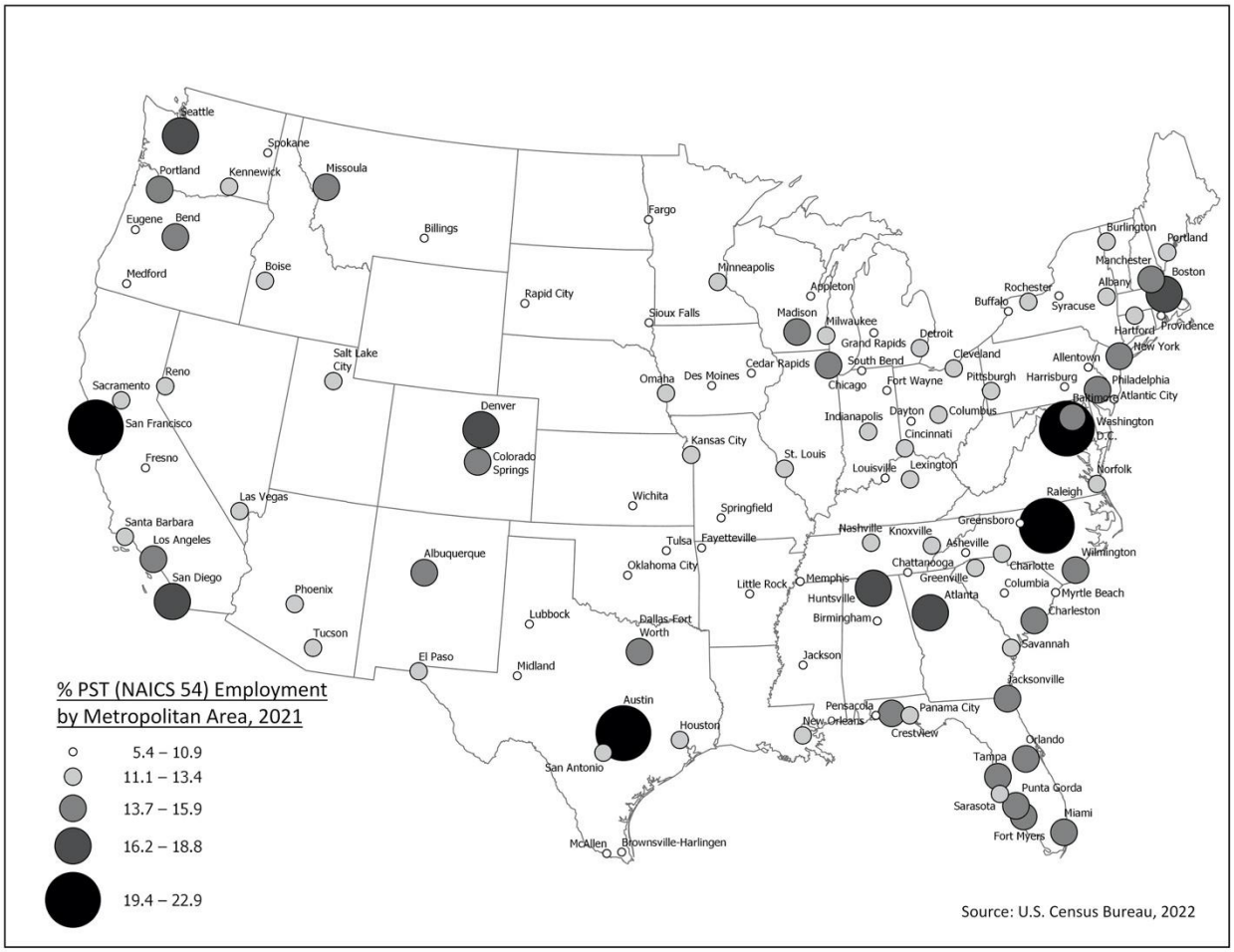


Figure 4. Spatial Distribution of PST Employment (%) (NAICS 54) by Metropolitan Area, 2021

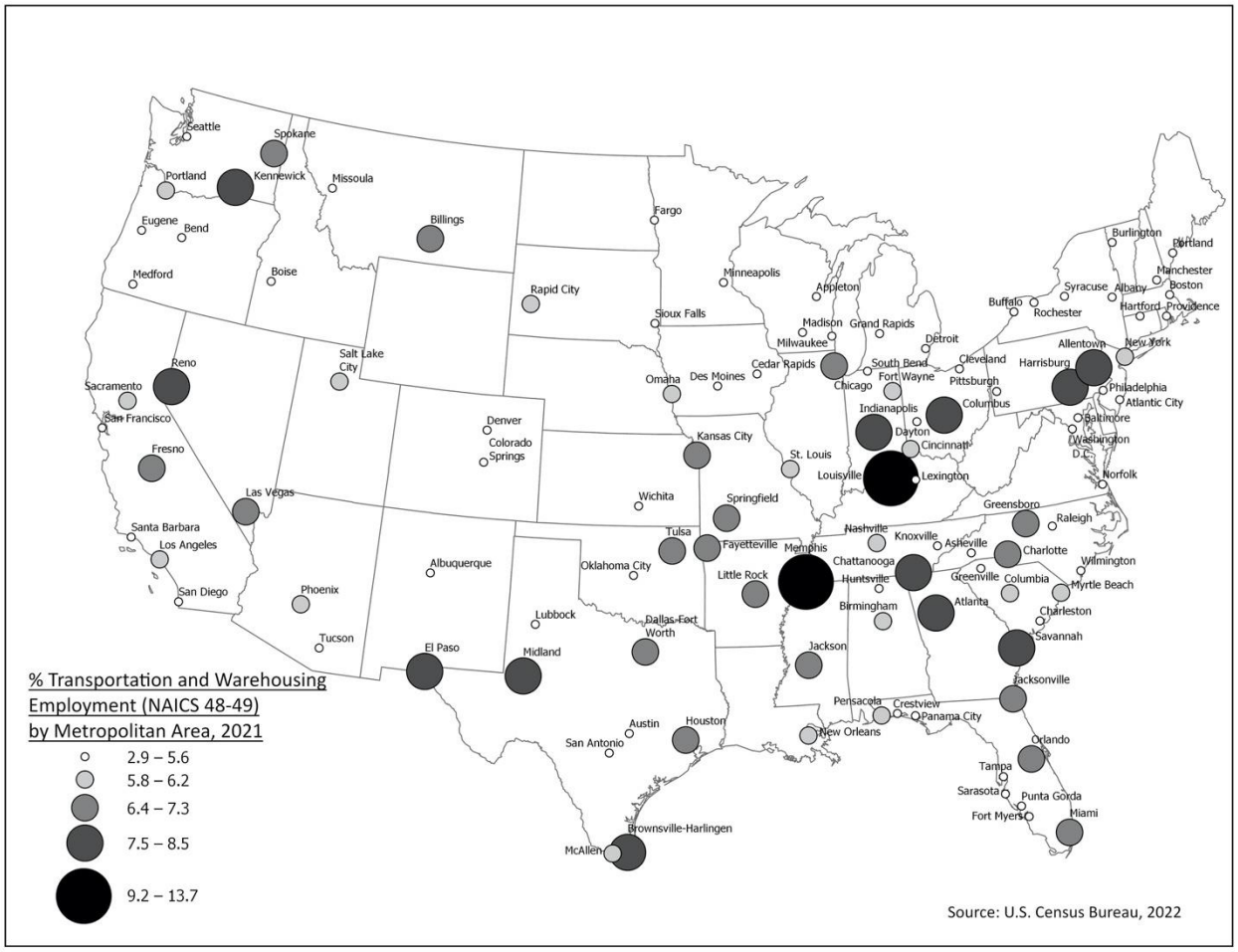


It is possible that the unprecedented impact of the pandemic may have corroded the explanatory power of the tradable services in terms of their impact on passenger demand. Business travel, which accounts for about 30% of all airline trips (*Aviation Week and Space Technology*, 2023) has continued to lag behind leisure travel since 2020. Approximately 30% of business trips are for intracompany purposes including internal meetings and employee training, and it is these sorts of trips between people that already know each other or share a common culture that have been largely replaced by Zoom or Teams meetings (*Aviation Week and Space Technology*, 2023). Despite all this, however, the COVID-19 mortality rate variable did not

feature in the final regression model, and it has a correlation coefficient of just -0.14 with passenger enplanements suggesting it does not systematically spatially co-vary in any significant way across the 111 metropolitan air passenger markets included in this analysis.

The other variable included in the regression model was the percent employed in Transportation and Warehousing (NAICS 48-49) (Figure 5) which conforms to Kasarda's (2000) expectations for aerotropolis-style development. According to Kasarda, an aerotropolis is essentially an airport-integrated region extending as far as 20 miles (30 kilometers) from the inner core area of aviation-oriented businesses. These aviation-oriented businesses include time-sensitive manufacturing distribution facilities such as aerospace, biopharma, electronics, and e-commerce; hotel, entertainment, retail, convention, trade, and exhibition complexes; and office buildings that house air-travel intensive executives and professionals (Aerotropolis, 2023). These businesses can benefit from the speed, agility, and connectivity afforded by a given airport. Also, metropolitan areas will then develop airport-related development nodes focused on generating jobs directly linked to mobility. In successful aerotropolis development regions like Memphis and Louisville – where FedEx and United Parcel Service (UPS) respectively are headquartered, the elevated accessibility to airport facilities and related cargo shipments tends to create a cluster of logistics and aviation-related companies and businesses that take advantage of proximity as a competitive advantage. Additionally, it should be noted that air cargo yields rose by 55 percent in 2021 compared to 2019 (McKinsey & Company, 2022). These unique circumstances during the COVID-19 pandemic likely triggered an unusually large number of air passengers particularly from higher-skilled aerotropolis workers in higher-income management and logistic positions.

Figure 5. Spatial Distribution of Transportation and Warehousing Employment (%) (NAICS 48-49) by Metropolitan Area, 2021



Furthermore, it should be noted that a stepwise regression analysis was also performed for the year 2022 using SPSS to analyze whether the relationship between air passenger demand and a group of predictor variables has changed from 2021. The regression model included the same predictor variables as in 2021 although the 2022 COVID-19 mortality rate data was not yet available on the CDC website (Table 2). The final regression model for the year 2022 featured the same four predictor variables as 2021: the percent of the workforce in Information, Transportation and Warehousing, PST, and FIRE, with a slightly higher R-squared value (i.e., 0.45). Given that Grubesic (2010) reported an R-squared value of 0.52 before the pandemic, the

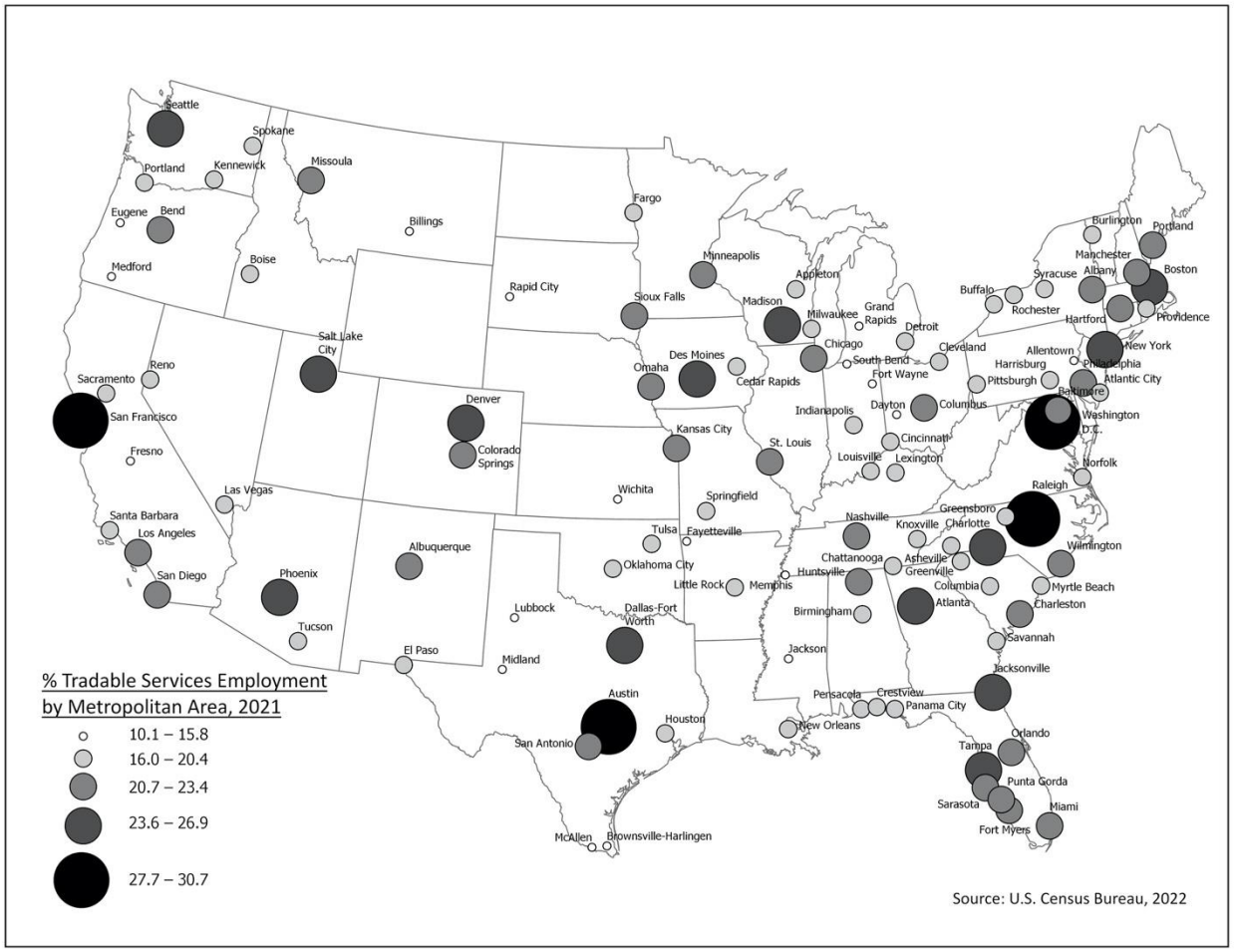
relationship between air passenger demand and metropolitan economies seems to be strengthening in the post-pandemic era.

4.3 2021-2022 Air Passenger Growth (%): Post-Pandemic Era

Given that the final regression model prominently featured the Information (NAICS 51), FIRE (NAICS 52-53), and PST (NAICS 54) sectors, it is likely that tradable services ***in the aggregate*** may have significantly shaped the geography of air passenger demand (Figure 6). Less unclear is whether or not those metropolitan areas with substantial tradable service sectors (%) experienced more robust recoveries in air passenger demand in the post-pandemic era when compared to those metropolitan areas with less substantial tradable service economies. This paper answered this question by focusing on the 2021-2022 enplanement growth rate (%) for those metropolitan economies with tradable services (%) above and below one standard deviation (i.e., 3.8) of the average share of tradable service jobs (i.e., 19.8%) (Figure 7). Those metropolitan economies that were one standard deviation above the mean in tradable services (i.e., >23.6%) experienced an average passenger growth rate of 33.4% which was nearly double the average growth rate of 18.4% for those metropolitan areas that generated a share of tradable services that was less than one standard deviation (i.e., <16.0%) below the mean.

It seems those metropolitan areas with a disproportionate share of tradable service jobs generated more resilient air passenger markets at least in terms of the manner in which they "bounced back" from the COVID-19 pandemic. Much of the literature has previously suggested that tradable services can act as a "booster shot" with respect to air passenger demand because of the tendency for tradable services workers to have elevated propensities to fly (Grubesic, 2010; Sheard, 2014).

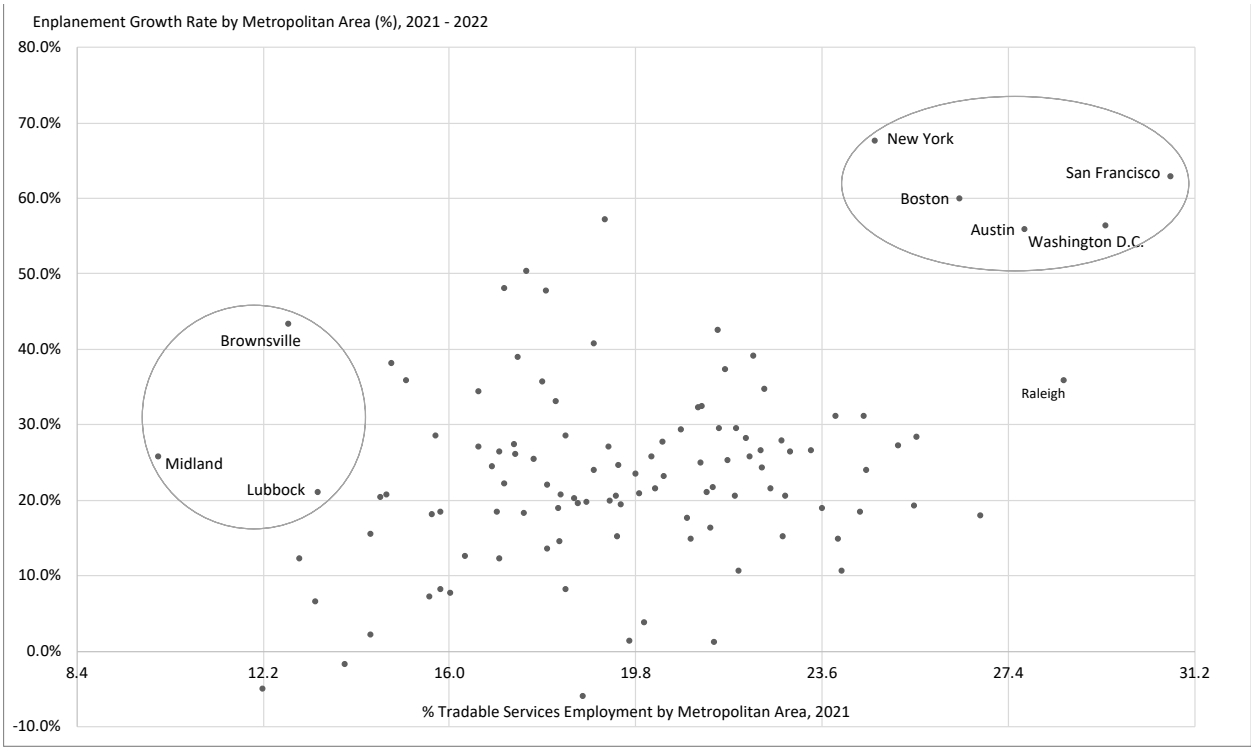
Figure 6. Spatial Distribution of Tradable Services Employment (%) by Metropolitan Area, 2021



The metropolitan labor market with the largest share of tradable services employment was San Francisco (i.e., 30.7%). San Francisco is the finance capital of the western US and thus a variety of banking offices are headquartered there (e.g., Wells Fargo). As a gateway to Silicon Valley, San Francisco is also a tech capital and a tech leader for early-stage venture capital financing, leading to an agglomeration of highly skilled and sophisticated Information-based firms (e.g., Salesforce and Twitter) with elevated propensities to fly. In part, because of this logic, the San Francisco metropolitan area generated the second highest 2021-2022 air passenger growth rate (i.e., 62.8%) in this study behind only the New York metropolitan area. The San

Francisco region is one of 12 multi-airport metropolitan economies included in this analysis. It hosts three major airports including the San Francisco International Airport, San José Mineta International Airport, and Oakland International Airport (Table 6). It should be noted that the 2021-2022 air passenger growth rate for the slowest-growing major airport in the San Francisco area was the Oakland International Airport (i.e., 37.3%), yet this airport still exceeded the 33.4% average passenger growth rate for the 17 metropolitan areas that generated robust, disproportionately large shares of tradable service jobs (i.e., greater than 1 standard deviation of the mean).

Figure 7. Tradable Services Employment (%) (2021) and 2021-2022 Enplanement Growth Rate (%) by Metropolitan Area



Source: FAA (2022, 2023) and U.S. Census Bureau (2022)

The metropolitan area with the most significant 2021-2022 enplanement growth rate in this analysis was New York (i.e., 67.4%), and it was also one of the ten most concentrated

tradable service sectors in the US (i.e., 24.7% of all jobs). Whereas San Francisco is the financial capital of the Western US, New York, particularly Wall Street, is typically considered the financial capital of the world. Nearly every large global financial institution has some presence in New York, and there are numerous headquarters of large investment firms (e.g., Goldman Sachs and Morgan Stanley) as well as banks (e.g., Citigroup and JPMorgan Chase). Manhattan is also an intense center of legal, management, consulting, and accounting firms at the city core. These and other related information-intensive and PST businesses are more likely to require easy face-to-face interaction to build trust and develop innovation (Debbage and Delk, 2001; Florida et al., 2015).

Table 6. Tradable Services Employment (%) (2021) and 2021-2022 Enplanement Growth Rate by Metropolitan Area and Airport

Metropolitan Areas	Tradable Services Employment (%) (2021)	2021-2022 Enplanement Growth Rate (%) by Metropolitan Area	Major Airports	2021-2022 Enplanement Growth Rate (%) by Airport
San Francisco	30.7	62.8	San Francisco International	74.1
			San José Mineta International	54.4
			Oakland International	37.3
New York	24.7	67.4	LaGuardia	83.6
			John F. Kennedy International	77.8
			Westchester County	67.6
			Newark Liberty International	50.0
			Long Island MacArthur	10.5

Source: U.S. Census Bureau (2022) and FAA (2022, 2023).

Much like the San Francisco region, it also should be noted that the New York metropolitan area included multiple airports that experienced a diverse range of enplanement growth rates (Table 6). LaGuardia Airport and John F. Kennedy International Airport were ranked first and second among all the airports included in this analysis, in terms of the 2021-

2022 enplanement growth rate (i.e., 83.6% and 77.8% respectively). Other metropolitan areas that seemed to have air passenger markets that really "bounced back" thanks, in part, to a robust tradable service economy included Boston, MA, Austin, TX, Washington D.C., and to a lesser extent, Raleigh, NC (Figure 7).

A visual inspection of the scatter graph (Figure 7) also suggested that three mid-sized Texas metropolitan areas appeared relatively anomalous, in part, because they generated fairly robust 2021-2022 enplanement growth rates even though their relative shares of tradable service jobs were fairly small. They included the Brownsville, Midland, and Lubbock metropolitan areas. The implication here seems to be that tradable services are not a panacea when it comes to "kick-starting" air passenger demand. More notably, the Brownsville metropolitan area generated the tenth fastest air passenger growth rate from 2021 to 2022 (i.e., 43.3%) even though it had the third lowest share of tradable service jobs (i.e., 12.7%). However, the Brownsville metropolitan area also ranked 14th based on the share of the labor pool employed in Transportation and Warehousing (NAICS 48-49) (i.e., 7.5% of all jobs), while the Midland metropolitan area ranked even higher (i.e., 11th and 7.8%) (Table 7). Additionally, Valley International Airport in the Brownsville metropolitan area was in the top 100 cargo airports by annual landed weight (FAA, 2022, 2023). It should be noted that Transportation and Warehousing (NAICS 48-49) (%) was the second variable to enter the final regression model (Table 4).

The Brownsville metropolitan area includes two airports: Valley International Airport (VIA) in Harlingen and Brownsville South Padre Island International Airport in Brownsville. The VIA is located 20 miles to the Northwest of the city of Brownsville, and the airport is more significant in terms of air passenger demand. The Harlingen Aerotropolis, a 479-acre site

adjacent to the VIA, has been developed to allow suppliers, manufacturers, distributors, and business people to connect to distant customers, clients, and markets in a more timely manner. In 2015, McCallum Sweeney Consulting certified the site as shovel-ready. Its centrality in the fast-growing Rio Grande Valley, proximity to the port of Harlingen, the Port of Brownsville, State Highway 550, the Los Indios Free Trade Bridge, and the VIA have additionally made it the ideal location for both local and global firms (City of Harlingen Texas, 2021). Indeed, major airlines (e.g., Southwest Airlines, United Airlines, and Delta Airlines) as well as logistics companies (e.g., DHL and FedEx) have already established partnerships with the VIA to establish strategic, successful operations within the airport vicinity.

Table 7. Top 14 Metropolitan Areas ranked by Transportation and Warehousing (NAICS 48-49) Employment (%), 2021

Rank	Metropolitan Area	Transportation and Warehousing (#)	Transportation and Warehousing (%)
1	Memphis	83,891	13.7
2	Louisville	57,350	9.2
3	El Paso	30,977	8.5
3	Reno	21,224	8.5
5	Atlanta	248,992	8.1
6	Allentown	33,575	8.0
6	Harrisburg	23,228	8.0
8	Chattanooga	21,437	7.9
9	Columbus	84,520	7.8
9	Kennewick	10,733	7.8
9	Midland	6,958	7.8
9	Savannah	15,074	7.8
13	Indianapolis	81,170	7.6
14	Brownsville	12,601	7.5
	Top 14 Average	52,266	8.44
	n = 111 Metropolitan Areas Average	55,620	5.79

Source: U.S. Census Bureau (2022)

Beyond logistics and transportation industries, the ideal location of the Harlingen Aertotropolis may also have attracted the aeronautical and aerospace industries. With SpaceX

building a launch facility in Boca Chica near Brownsville, the Harlingen Aerotropolis appears to be home to the new aerospace cluster in South Texas. Although SpaceX's final plan for Brownsville remains unknown, a direct flight from/to Austin has been already established by Southwest Airlines to provide greater access for SpaceX and the related employees (Rio Grande Guardian, 2022). An efficient air transportation network is particularly crucial for those who engage in the administrative and auxiliary sectors (Debbage and Delk, 2001). These sectors, often involved in collaborative research and development activities, tend to benefit significantly from frequent and direct contact with key personnel in other metropolitan markets. Furthermore, the new launch facility was expected to create additional jobs and economic activity in the city of Brownsville (*USA TODAY*, 2014), which might trigger additional air traffic demand in more extended areas of the metropolitan economy as the operation is further facilitated.

The significant enplanement growth rate in the Brownsville metropolitan area in the post-pandemic era seems to have been attributed not only to business activities but also to leisure activities, which were particularly enhanced under the severe pandemic restrictions. Recently, Southwest Airlines has nearly doubled their daily flight to/from the VIA, and the increase in seats in the markets contributed to the increase in leisure passengers in the Brownsville metropolitan area, which serves as a gateway to South Padre Island. According to *Rio Grande Guardian* (2023), three out of every four tourists that visited South Padre Island flew to and from the VIA. These multiple unique factors likely contributed to the unprecedented air passenger growth rate in the Brownsville metropolitan area although the tradable services employment share was fairly limited.

CHAPTER V: CONCLUSION

This paper sought to geographically and statistically investigate whether or not a relationship existed between air passenger demand by metropolitan area and certain business activities on the ground during the peak of the COVID-19 pandemic. The geography of air passenger demand suggested a substantial spatial concentration existed characterized by a select few major international gateways (e.g., New York, Los Angeles, and Miami) and large, domestic airline hubs (e.g. Atlanta, Dallas-Fort Worth, and Chicago). Furthermore, a stepwise regression analysis suggested that metropolitan markets were more likely to generate air passengers if they contained a disproportionate share of employment in tradable services, especially in the Information, PST, and FIRE sectors, as well as in Transportation and Warehousing. These results seem to confirm some of the earlier research (Grubesic, 2010; Liu et al., 2006), which articulated that a regional workforce with a strong tradable services sector can substantially impact air transport provision. While the COVID-19 mortality rate variable did not feature in the final regression model, the slightly lower R-squared value in this paper compared to past research suggests that something may be slightly amiss. Before definitive statements can be made, much more research needs to be conducted particularly focused on the changing nature of home and work, largely as a result of the COVID-19 pandemic, and how that might impact the geography of air passenger demand in the long term.

Overall, the geography of air passengers by metropolitan area reminds us of the crucial role that spatial concentration and hierarchy play in shaping air passenger demand in the US. Additionally, even during the peak of the COVID-19 pandemic, certain business activities on the ground, particularly tradable services, can still help to generate additional air passenger demand and enhance competitive advantage.

REFERENCES

Aerotropolis. 2023. About the Aerotropolis. Retrieved from: https://aerotropolis.com/airportcity/index.php/about/

Aviation Week and Space Technology. 2023. Up Front – Kevin Michaels. July 31-August 13, p.9.

Blonigen, B. and A, Cristea. 2012. Airports and Urban Growth: Evidence from a Quasi-Natural Policy Experiment. *National Bureau of Economic Research*, Working Paper 18278, Cambridge: Mass.

Brookings Institution. 2022. Superstars, rising stars, and the rest: Pandemic trends and shifts in the geography of tech. Retrieved from: https://www.brookings.edu/articles/superstars-rising-stars-and-the-rest-pandemic-trends-and-shifts-in-the-geography-of-tech/

Brueckner, J. K. 2003. Airline Traffic and Urban Economic Development. *Urban Studies*. 40(8). 1455-1469.

Button, K. and Yuan, J. 2013. Airfreight Transport and Economic Development: An Examination of Causality. *Urban Studies*. 50(2). 329-340.

Centers for Disease Control. 2022. *Provisional Mortality Data – United States, 2021*. Retrieved from: https://www.cdc.gov/mmwr/volumes/71/wr/mm7117e1.htm

Centers for Disease Control. 2023. *About Underlying Cause of Death, 2018-2021, Single Race*. Retrieved from: https://wonder.cdc.gov/ucd-icd10-expanded.html

Centers for Disease Control. 2023. *COVID-19 Mortality Update – United States, 2022*. Retrieved from: https://www.cdc.gov/mmwr/volumes/72/wr/mm7218a4.htm

City of Harlingen Texas. 2021. 2016-2021 Progress Report. p.48. Retrieved from: https://www.harlingentx.gov/upload/page/0052/docs/Comp_Plan_Progress_Report.pdf

Debbage, K. and Delk, D. 2001. The Geography of Air Passenger Volume and Local Employment Patterns by U.S. Metropolitan Core Area: 1973-1996. *Journal of Air Transport Management.* 7(3). 159-167.

Economic Policy Institute. 2019. Updated multipliers for the U.S. economy. Retrieved from: https://www.epi.org/publication/updated-employment-multipliers-for-the-u-s-economy/

Federal Aviation Administration. 2022. *Airport Categories*. Retrieved from: https://www.faa.gov/airports/planning_capacity/categories

Federal Aviation Administration. 2022. *CY 2021 Enplanements at All Commercial Service Airports.* Retrieved from: https://www.faa.gov/airports/planning_capacity/passenger_allcargo_stats/passenger/cy21_commercial_service_enplanements

Federal Aviation Administration. 2023. *CY 2022 Enplanements at All Commercial Service Airports.* Retrieved from: https://www.faa.gov/airports/planning_capacity/passenger_allcargo_stats/passenger/cy22_commercial_service_enplanements

Federal Aviation Administration. 2022. *CY 2021 Qualifying Cargo Airports, Rank Order, and Percent Change from 2020*. Retrieved from: https://www.faa.gov/airports/planning_capacity/passenger_allcargo_stats/passenger/cy21_cargo_airports

Federal Aviation Administration. 2023. CY 2022 Qualifying Cargo Airports, Rank Order, and Percent Change from 2021. Retrieved from: https://www.faa.gov/airports/planning_capacity/passenger_allcargo_stats/passenger/cy22_cargo_airports

Florida, R., Mellander, C., and Holgersson, T. 2015. Up in the air: the role of airports for regional economic development. *The Annals of Regional Science*. 54. 197-214.

Green, R. K., 2007. Airports and Economic Development. Real Estate Economics. 35(1). 91-112.

Grubesic, T. H. 2010. Spatial variations in broadband and air passenger service in the United States. *Geojournal.*75(1). 57-77.

Hanson, D., Delibasi, T.T., Gatti, M., and Cohen. S. 2022. How do changes in economic activity affect air passenger traffic? The use of state-dependent income elasticities to improve aviation forecasts. *Journal of Air Transport Management*. 98. 102147.

Kasarda, J. D. 2000. Aerotropolis: Airport-driven urban development. *Urban Land Institute*. 32-41.

Kim, M. and Sohn, J. 2022. Passenger, airline, and policy responses to the COVID-19 crisis: The case study of South Korea. *Journal of Air Transport Management*. 98. 102144.

Lakew, P. A. 2015. Airport Traffic and Metropolitan Economies: Determinants of Passenger and Cargo Traffic. *Transportation Research Record: Journal of the Transportation ResearchBoard*. 2471(1). 58-72.

Liu, Z. J., Debbage, K., and Blackburn, B. 2006. Locational Determinants of Major U.S. Major Air Passenger Markets by Metropolitan Area. *Journal of Air Transport Management.* 12(6). 331-341.

McKinsey and Company. 2022. Taking stock of the pandemic's impact on global aviation. Retrieved from: https://www.mckinsey.com/industries/travel-logistics-and-infrastructure/our-insights/taking-stock-of-the-pandemics-impact-on-global-aviation

Mosbah, S. and Ryerson, M. S. 2016. Can US Metropolitan Areas Use Large Commercial Airports as Tools to Bolster Regional Economic Growth? *Journal of Planning Literature*. 31(3). 317-333.

Neal, Z. 2011. The Causal Relationship Between Employment and Business Networks in U.S. Cities. *Journal of Urban Affairs*. 33. 167-184.

Neal, Z. 2012. Creative Employment and Jet Set Cities: Disentangling Causal Effects. *Urban Studies*. 49(12). 2693-2709.

New York Times. 2023. The Places Most Affected by Remote Workers' Moves Around the Country. Retrieved from: https://www.nytimes.com/interactive/2023/06/17/upshot/17migration-patterns-movers.html

Rio Grande Guardian. 2022, Dec 5. *VIA*. YouTube. Retrieved from: https://youtu.be/2jgBtqEhD0c?si=jjMmfs5EXsJry42-

Rio Grande Guardian. 2023. Esterly cannot believe the record number of passengers flying into Valley International Airport. Retrieved from: https://riograndeguardian.com/esterly-cannot-believe-the-record-number-of-passengers-flying-into-valley-international-airport/

Sheard, N. 2014. Airports and urban sectoral employment. *Journal of Urban Economics*. 80. 133-152.

USA TODAY. 2014. Texas border town to become next Cape Canaveral. Retrieved from: https://www.usatoday.com/story/money/business/2014/10/05/spacex-brownsville-spaceport/16584729/

United States Department of Transportation. Bureau of Transportation Statistics. 2022. *U.S. Scheduled Service Airline 2021 Passengers Increased 83% from 2020, Decreased 27% from Pre-pandemic 2019 (Preliminary)*. Retrieved from: https://www.bts.gov/newsroom/us-

scheduled-service-airline-2021-passengers-increased-83-2020-decreased-27-pre-pandemic#:~:text=For%20the%20calendar%20year%202021,%25)%20from%20pre%2Dpandemic%202019

U.S. Census Bureau. 2020. *Understanding and Using ACS Single-Year and Multipleyear Estimate*. 13-16. Retrieved from: https://www.census.gov/content/dam/Census/library/publications/2018/acs/acs_general_handbook_2018_ch03.pdf

U.S. Census Bureau. 2022. *American Community Survey (1-Year Estimates).* B19301 Per Capita Income in the past 12 months. Retrieved from: https://data.census.gov/table?q=B19301&g=010XX00US$31000M1&y=2021

U.S. Census Bureau. 2022. *American Community Survey (1-Year Estimates).* DP03 Selected Economic Characteristics. Retrieved from: https://data.census.gov/table?q=DP03&g=010XX00US$31000M1&y=2021&tid=ACSDP1Y2021.DP03

U.S. Census Bureau. 2022. *American Community Survey (1-Year Estimates).* S1501 Educational Attainment. Retrieved from: https://data.census.gov/table?q=S1501&g=010XX00US$31000M1&y=2021&tid=ACSST1Y2021.S1501

U.S. Census Bureau. 2022. *American Community Survey (1-Year Estimates).* S1903 Median Income in the past 12 months. Retrieved from: https://data.census.gov/table?q=S1903&g=010XX00US$31000M1&y=2021&tid=ACSST1Y2021.S1903

U.S. Census Bureau. 2023. *American Community Survey (1-Year Estimates).* B19301 Per Capita Income in the past 12 months. Retrieved from: https://data.census.gov/table?q=B19301&g=010XX00US$31000M1&y=2021

U.S. Census Bureau. 2023. *American Community Survey (1-Year Estimates).* DP03 Selected Economic Characteristics. Retrieved from: https://data.census.gov/table?q=DP03&g=010XX00US$31000M1&y=2021&tid=ACSDP1Y2021.DP03

U.S. Census Bureau. 2023. *American Community Survey (1-Year Estimates).* S1501 Educational Attainment. Retrieved from: https://data.census.gov/table?q=S1501&g=010XX00US$31000M1&y=2021&tid=ACSST1Y2021.S1501

U.S. Census Bureau. 2023. *American Community Survey (1-Year Estimates).* S1903 Median Income in the past 12 months. Retrieved from: https://data.census.gov/table?q=S1903&g=010XX00US$31000M1&y=2021&tid=ACSST1Y2021.S1903

Van De Vijver, E., Derudder, B., and Witlox, F. 2016. Air Passenger Transport and Regional Development: Cause and Effect in Europe. *Traffic and Transportation*. 28(2). 143-154.